1. SET UP the integral in spherical coordinates that gives the volume of ice cream stuffed inside the cone $\varphi = \pi/6$, with top surface given by $x^2 + y^2 + z^2 = 9$. Do NOT compute. How tall is the cone without the ice cream and what is its top radius?

2. Use Green’s Theorem to rewrite $\oint_C y \, dx + x^2 \, dy$ as a completely set up double integral, where $C$ is the curve formed by running from the origin along the $x$-axis to $x = 2$, then straight up, and finally back to the origin along $y = x^3/4$. Do NOT compute.
3. Let \( \mathbf{G} = \left( \frac{2xy}{1 + x^2}, \ln(1 + x^2) + \sin y \right) \).

a. On what domain is \( \mathbf{G} \) defined? Explain why \( \mathbf{G} \) is a conservative vector field.

b. Compute a potential function \( \varphi(x, y) \) for \( \mathbf{G} \).

c. Compute \( \int_C \mathbf{G} \cdot d\mathbf{r} \), where \( C \) is any smooth path (e.g., the line segment) from \( P(0, \pi/3) \) to \( Q(1, \pi) \). Why does the choice of path not matter?